doi:10.1017/S1431927622004251
Microsc. Microanal. 28 (Suppl 1), 2022
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XPS Surface analysis augmented using correlative spectroscopy and microscopy

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Across a wide range of application areas, understanding the chemistry and structure of surfaces and interfaces is crucial. In the last fifty years, X-ray photoelectron spectroscopy (XPS) has become established as a one of the key techniques for measuring surface and interface chemistry, and advances in instrumentation have enabled it to keep pace with the requirements for both academia and industry. XPS can deliver quantified surface chemistry measurements, and by using depth profiling, an understanding of layer and interfacial chemistry, but the limit on spatial resolution for XPS can prevent it from determining how the surface structure is related to the measured chemical properties. For example, how the changing morphology of the surface during a depth profile could influence the measured composition would be challenging to determine using XPS.

Other experimental techniques which are unable to match the surface selectivity of XPS are able to provide complementary information to extend the data from XPS. Electron microscopy can provide high resolution imaging, with elemental composition provided by energy dispersive X-ray microanalysis, but without the same surface selectivity seen with XPS or Auger electron spectroscopy (AES). This can be a perfect complement to XPS analysis, so long as the same points of interest can be identified. Molecular spectroscopy, such as FTIR or Raman, can also provide complementary information to XPS, albeit with different sampling depths, which can be extremely useful to validate measurements or confirm particular molecular structures using the wide range of spectral libraries available for those techniques.

In this presentation, we will describe how instrumentation and software has been designed to facilitate correlative analysis. This takes one of two approaches: either measuring samples in an instrument designed to integrate XPS with reflected electron energy loss spectroscopy (REELS), low energy ion scattering (ISS or LEIS), and Raman spectroscopy, or by correlating data from SEM analysis with data from surface analysis instruments in an automated fashion. This will be complemented with examples in which utilizing correlative methods have led to a greater understanding of the material under investigation, including using XPS and SEM to investigate the impact of monatomic and gas cluster ion beams on III-V semiconductor materials, where the deviation from the expected stoichiometry during depth profile is related to the structures formed in the etched area. We will also show how the combination of XPS, Raman and SEM can be used to characterize 2D nano-materials, and understand polymer structures.

https://doi.org/10.1017/S1431927622004251 Published online by Cambridge University Press